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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015/2016

EEL4106 – HIGH VOLTAGE ENGINEERING
(LE)

8 MARCH 2016
9.00 a.m – 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 3 pages including the cover page with 4 Questions only.
2. Answer **ALL** questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

Question 1

- (a) With proper labelling, draw the voltage doubler circuit suggested by Greinacher to obtain $2V_m$. [4 Marks]
- (b) A Cockcroft-Walton voltage multiplier has 10 stages with capacitances, all equal to $0.03 \mu\text{F}$. The supply transformer secondary voltage is 130 kV at a frequency of 150 Hz. If the load current is 5 mA, find [4 Marks]
- (i) The percentage ripple, and [4 Marks]
- (ii) The percentage regulation. [3 Marks]
- (c) Briefly explain **TWO** advantages of resonant transformer [3 Marks]
- (d) The elements of the circuit shown in Figure Q1(d) for producing lightning impulse voltages are $C_1 = 10 \mu\text{F}$, $C_2 = 40 \text{ pF}$, $R_1 = 2 \text{ k}\Omega$, $R_2 = 8 \text{ k}\Omega$. Obtain α and β to be used in the equation $\left(v_o(t) = \frac{V}{R_1 C_2} (e^{-\alpha t} - e^{-\beta t}) \text{ kV} \right)$ [10 Marks]

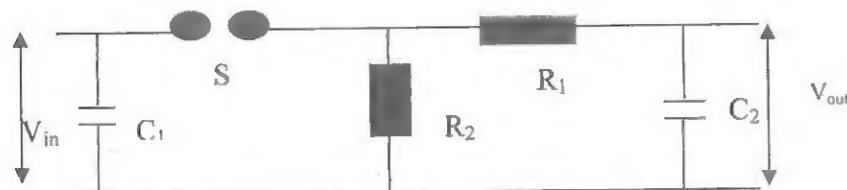


Figure Q1(d)

Question 2

- (a) List out **ONE** advantage and **TWO** disadvantages of uniform field electrode gaps. [3 Marks]
- (b) An electrostatic voltmeter has a movable circular plate with cross-sectional area of 100 cm^2 . If the distance between the plates during a measurement is 5 mm, determine the potential difference when the force of attraction is 0.005 N. [4 Marks]
- (c) Draw a Schering bridge circuit to determine the loss factor of a specimen and derive the necessary expressions. An insulation specimen is tested at 50 Hz using the Schering Bridge. The bridge has a standard capacitor, C_s of 100 pF , a non-inductive resistor, R_4 of 500Ω in parallel with a variable capacitance C_4 , and a non-inductive variable resistor R_3 . If balance is obtained with $C_4 = 0.25 \mu\text{F}$ and $R_3 = 150 \Omega$, determine the loss factor, capacitance and resistance of the specimen using series equivalent model. [12 Marks]
- (d) Briefly explain the following terms as applied to high voltage testing. [2 Marks]
- (i) Withstand voltage [2 Marks]
- (ii) 50% impulse flashover voltage [2 Marks]
- (iii) Disruptive discharge voltage [2 Marks]

Continued...

Question 3

- (a) Briefly explain the term 'breakdown' as used to describe breakdown in gaseous medium, and list out TWO mechanisms that explain the breakdown of gaseous medium under a static uniform field. [3+2 Marks]

- (b) Figure Q3 shows the void in the solid dielectric material, where t is the thickness of the cavity, and d is the thickness of the solid dielectric material.

- (i) Draw the equivalent circuit of a dielectric material with a cavity [3 Marks]
 (ii) Derive expressions for the capacitance of the cavity, C_c , and solid dielectric material, C_s . [4 Marks]
 (iii) Show that if a voltage V is applied across the dielectric, then the voltage

across the cavity $V_v = \frac{V}{1 + \frac{1}{\epsilon_r} \left(\frac{d}{t} - 1 \right)}$, where ϵ_r is the relative permittivity.

[7 Marks]

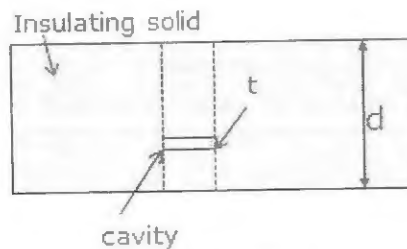


Figure Q3

- (c) The breakdown of a certain gas occurs at a uniform electric field between two plane electrodes having a spacing of 1.0 cm. If the Townsend's second ionization coefficient γ is 0.001 find the value of the Townsend's primary ionization coefficient α . [6 Marks]

Question 4

- (a) List out TWO advantages and TWO disadvantages of the rod gap (horn gap). [6 Marks]

- (b) Draw the V-I curve of a surge arrester and briefly explain THREE conduction regions of V-I characteristics of the surge arrester. [8 Marks]

- (c) A rectangular voltage wave of 3000 kV is traveling along a line of surge impedance 300Ω towards a lightning arrester. The arrester protective level is 2000 kV and is assumed to be fairly constant at all current values discharged by the arrester. Calculate

- (i) the current flowing through the line before the surge voltage reaches the arrester terminal, [2 Marks]
 (ii) the current through the arrester, [2 Marks]
 (iii) reflected current in the line, I_2 , reflected voltage in the line, V_2 , refracted voltage into the arrester, V_3 , reflected coefficient of voltage and refraction coefficient of voltage, and [5 Marks]
 (iv) the arrester's resistance. [2 Marks]

End of Paper.